

## The Chiton Fauna of Cocos Island, Costa Rica (Mollusca: Polyplacophora) with the Description of Two New Species

Antonio J. Ferreira

*We regret to announce the death of Antonio J. Ferreira on 19 May 1986. Inquiries and requests for his scientific work may be sent to the Department of Invertebrate Zoology and Geology, California Academy of Sciences, San Francisco, California 94118.*

*Abstract.*—Six species of chitons are here recognized at Cocos Island, Costa Rica, including two new species, an *Ischnochiton* and an *Acanthochitona*. The reported presence on the island of *Chiton goodallii* and *Acanthochitona hirudiniformis* has not been corroborated.

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Cocos Island lies at 5°32'N, 87°04'W, some 500 kms (300 miles) southwest of Punta Arenas, Costa Rica, 600 kms (350 miles) northeast of the Galápagos Islands. At the eastern edge of the Indo-Pacific, in the path of the North Equatorial Countercurrent, and within the reach of currents from western American shores, the fauna of Cocos Island is of particular interest. Although Cocos is considered to be part of the Panamanian Province (Briggs 1974), its marine fauna has a considerable admixture of Indo-West Pacific species. With respect to mollusks, Hertlein (1963) found that among 88 species recorded at the island, 88% are Panamic, 6% Indo-Pacific, and 6% endemic; Emerson and Old (1964), Montoya (1983), and Shasky (1983, 1985), reported comparable observations.

This report on the chiton fauna of Cocos Island is based mostly upon material obtained by Donald R. Shasky (DRS) (Apr. 1983; Mar. 1984; May, 1985) and myself (AJF) (Nov. 1984), from aboard the schooner VICTORIA; additional material was found in the collections of the California Academy of Sciences, San Francisco, California (CAS), U.S. National Museum of Natural History, Washington, D.C. (USNM), and the Los Angeles County Museum of Natural History (LACM).

Six species of chitons are here recognized at Cocos Island, Costa Rica, two new to science:

- Chiton stokesii* Broderip, 1832
- Placiphorella blainvillii* (Broderip, 1832)
- Stenoplax boogii* (Haddon, 1886)
- Lepidozona rothi* Ferreira, 1983
- Ischnochiton victoria* Ferreira, spec. nov.
- Acanthochitona shaskyi* Ferreira, spec. nov.

The reported presence of two other species at Cocos Island—*Chiton goodallii* Broderip, 1832, and *Acanthochitona hirudiniformis* (Sowerby, 1832)—are considered to be either misidentifications, or represent such rare and unlikely occur-

rences that they cannot be accorded permanent status in the chiton fauna of the island.

Systematic Treatment  
 Polyplacophora Gray, 1821  
 Order Neoloricata Bergenhayn, 1955  
 Suborder Ischnochitonina Bergenhayn, 1930  
 Family Ischnochitonidae Dall, 1889  
*Ischnochiton* Gray, 1847a

Type species: *Chiton textilis* Gray, 1828, by subsequent designation (Gray 1847b).

*Ischnochiton victoria* Ferreira, spec. nov.

Figs. 1-7

Diagnosis: Very small chitons, up to 3.5 mm long. Valves brightly colored in reddish tones, often with touches of brown or blue; round-backed, not carinate, not beaked; posterior valve remarkably inflated, mucro central, inconspicuous, postmucro convex, at sharp slope. Articulamentum white; sutural laminae sharp, small, separated by wide sinus; teeth small, sharp; slits 9/10-1-9/10. Girdle scales small (up to 100  $\mu\text{m}$ ) with 12-14 striations. Radula major lateral teeth tricuspid.

Type material and locality: Holotype (CAS 061096), entire specimen, off Roca Sucia, near Wafer Bay, Cocos Island, Costa Rica (5°33'N, 87°02'W) at 24 m; 17 loose valves (CAS 061097; LACM 2124; D. R. Shasky Colln.) designated as paratypes, 16 found at same locality as holotype, in sand, at 18-34 m, 1 also found in sand, 1.5 km NE of Manuelita Id., off Cocos Island, at 91-95 m.

Description: Holotype about 3.5 mm long, elongate, round backed; valves very thin, not carinate, not beaked, posterior edges straight. Tegmentum in reddish tones mottled with white, particularly on valve v, with dark brown and blue markings on pleural areas. Anterior valve broken, 1/3 missing. Sculpture of anterior valve and lateral areas of intermediate valves limited to 6-8 coarse concentric rugosities (Figs. 1 and 2); lateral areas hardly elevated; central areas uniformly sculptured with minute, roundish pits, 7-8  $\mu\text{m}$  in diameter, close together (Fig. 3). Posterior valve very elevated, inflated (Fig. 4 and 5); mucro inconspicuous, about central; postmucro sloping sharply, convex, with vague concentric rugosities. Articulamentum translucent, colors of tegmentum showing through; sutural laminae short, very thin, sharp; sinus very wide; relative width of sinus on valve viii (width of sinus / width of sutural laminae), 1.2; insertion teeth short, sharp; slits 8-1-10. Girdle dorsal surface covered with imbricate, flat scales, up to 110  $\mu\text{m}$  long, with 12-14 striations (Fig. 6A); girdle ventral surface with transparent, rectangular scales, 30  $\times$  15  $\mu\text{m}$  (Fig. 6B), arranged in columns. Radula (Fig. 7) 1.3 mm long comprising some 35 rows of mature teeth; median tooth 11  $\mu\text{m}$  wide at anterior blade, narrowing posteriorly; first lateral teeth about 38  $\mu\text{m}$  long, widely concave at outer border, with prominent knob at antero-lateral corner; spatulate teeth, simple, 55  $\mu\text{m}$  long; major lateral teeth with tricuspid head, 25  $\mu\text{m}$  wide; outer marginal teeth 30  $\times$  30  $\mu\text{m}$ .

Paratypic material consists of 17 loose valves found in sand ("grunge") mostly from 18-34 m at Roca Sucia (DRS): 4 anterior, 2 intermediate, and 11 posterior valves. Tegmental color variegated from cream to red. Largest posterior valve 1.1 mm long, 1.6 mm wide. Slit formula 9/10-1-10/12.

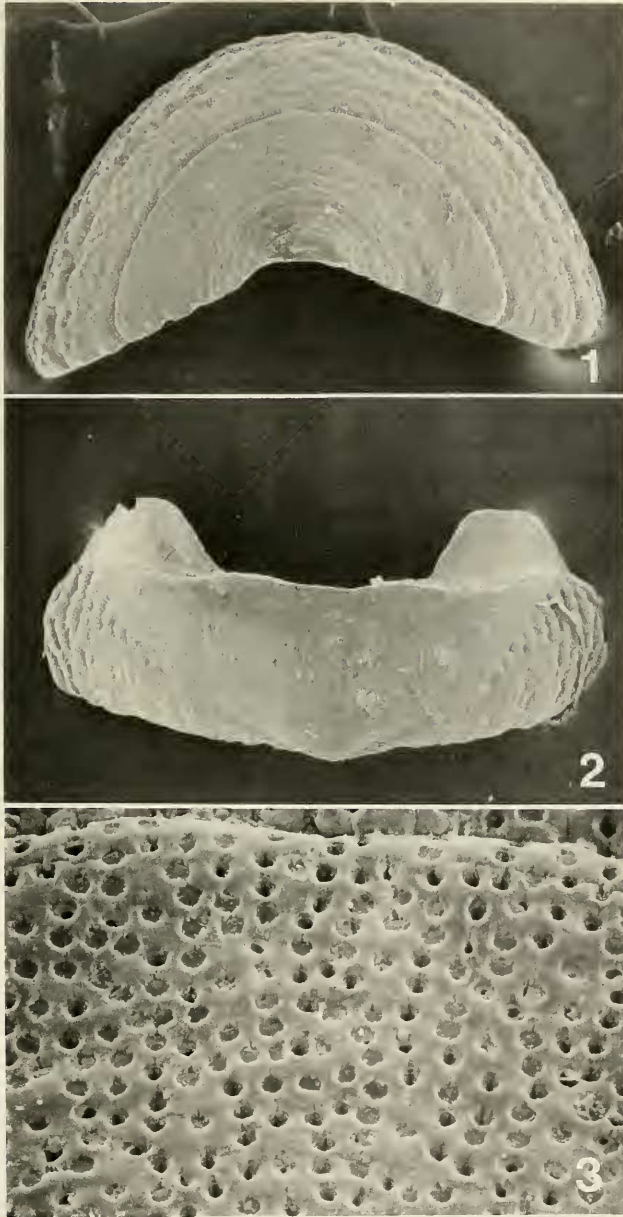


Fig. 1. *Ischnochiton victoria* Ferreira, spec. nov. Paratype (CAS 0610979): Anterior valve, dorsal surface. SEM micrograph, courtesy of Terrence Gosliner.

Fig. 2. *Ischnochiton victoria* Ferreira, spec. nov. Holotype (CAS 061096): Intermediate valve, dorsal surface. SEM micrograph, courtesy of Terrence Gosliner.

Fig. 3. *Ischnochiton victoria* Ferreira, spec. nov. Holotype (CAS 061096): Intermediate valve, close-up of central area ( $\times 400$ ). SEM micrograph, courtesy of Terrence Gosliner.

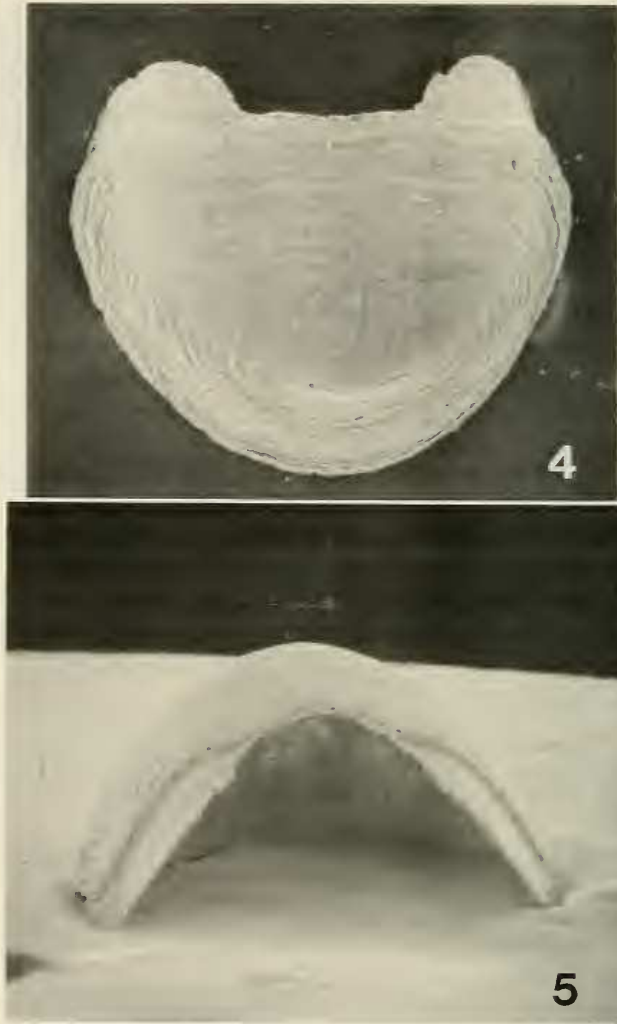


Fig. 4. *Ischnochiton victoria* Ferreira, spec. nov. Paratype (CAS 061097): Posterior valve, dorsal surface. SEM micrograph, courtesy of Terrence Gosliner.

Fig. 5. Same specimen as in Fig. 4: Frontal view of posterior valve. SEM micrograph, courtesy of Terrence Gosliner.

Distribution: *Ischnochiton victoria* is known only from Cocos Island, Costa Rica.

Remarks: The single entire specimen of *Ischnochiton victoria* was obtained through a unique method in chiton collecting: “. . . I was determined to spend most of the dive [at Roca Sucia, Cocos Island] just shaking coral slabs [into the collecting bag] . . . After returning to the boat I [poured] the contents of the bag into a basin of water and washed out the interior of the bag in the basin. I then put the material through screens and saved everything except the silt. What I saved was then dried and bagged for examination under the microscope . . . and

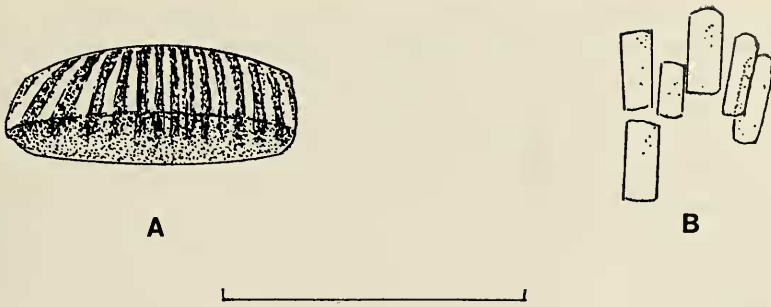


Fig. 6. *Ischnochiton victoria* Ferreira, spec. nov. Holotype (CAS 061096): Girdle elements: A—Scale of upper surface; B—Scales of undersurface. Camera lucida drawing. Bar = 100  $\mu$ m.

it was from this grunge that the live specimen of the *Ischnochiton* [*victoria*] was found.” (Donald R. Shasky, in litt., 3 Sept. 1985).

For its color (? with bright blue spots), elongate body, minute, striate girdle scales, and radula with tricuspid major lateral teeth, *I. victoria* may be confused with *I. rugulatus* (Sowerby 1832). The differential diagnosis between the two species is important since *I. rugulatus*, although not found at Cocos, has a range—along the western American coast from Malarrimo Point, Baja California, Mexico (27°04'N) to Isla Lobos de Afuera, Peru (6°57'S), as well as Galápagos Islands, Revillagigedo Islands, and Hawaii (Ferreira 1983)—which could well include Cocos Island. *Ischnochiton victoria* differs from *I. rugulatus* not only in the smaller size of its specimens and subtle distinctions in the tegmental sculpture, but clearly in 1) peculiarly “inflated” posterior valve, almost defining a perfect fourth of a hollow sphere, 2) convex postmucro, and 3) very wide sinus.

Noteworthy is the fact that *I. victoria* is quite similar to *I. pseudovirgatus* Kaas,

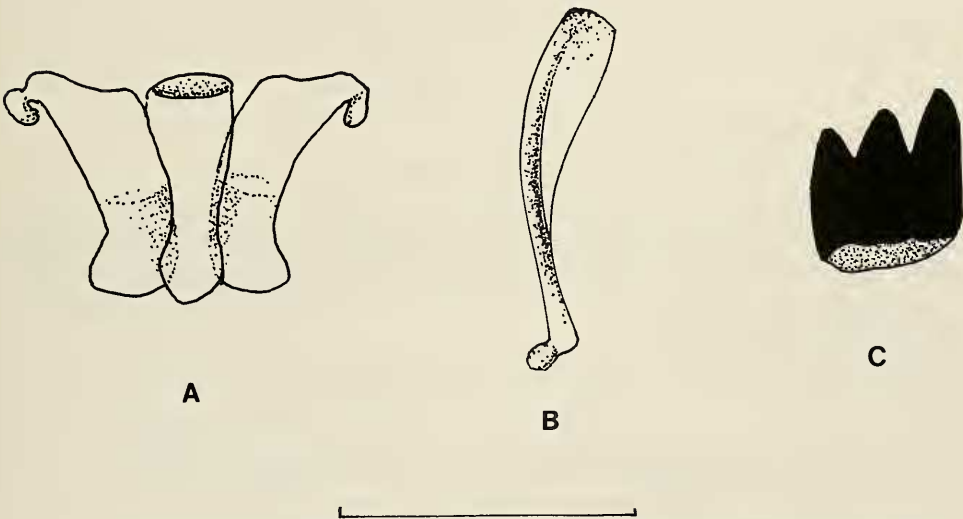


Fig. 7. *Ischnochiton victoria* Ferreira, spec. nov. Holotype (CAS 061096): Radula: A—Median and first lateral teeth; B—Spatulate tooth; C—Head of major lateral teeth. Camera lucida drawing. Bar = 50  $\mu$ m.

1972, a tropical western Atlantic species known at Curacao, Trinidad, Florida, and Barbados (Ferreira 1985). Specimens of both species are very small, elongate, parallel-sided, colored often with brown designs and blue spots, valves thin and roundbacked, very wide sinus, sharp insertion teeth, small, striated girdle scales, and radula with tricuspid major lateral teeth. Morphologically, *I. victoria* and *I. pseudovirgatus* may be considered sibling species. However, they differ in 1) the tegmental surface (dull, micro-pitted in *I. victoria*; smooth, almost shiny in *I. pseudovirgatus*), and 2) the posterior valve (elevated, inflated, convex postmucro in *I. victoria*; not elevated or elevated, concave postmucro in *I. pseudovirgatus*). Likely the two species share a not too distant ancestor, perhaps having been separated by the rise of the Isthmus of Panama.

The species is named *victoria* [a noun in apposition] after the schooner VICTORIA and her crew who made possible these collecting trips to Cocos Island.

*Lepidozona* Pilsbry, 1892

Type species: *Chiton mertensii* Middendorff, 1847, by original designation.

*Lepidozona rothi* Ferreira, 1983

*Lepidozona rothi* Ferreira, 1983:316–317, figs. 19–22.

Material examined: 3 specimens, 10.8 mm, 6.1 mm, 4.8 mm long (including girdle), dredged at Chatham Bay, at 46–53 m (DRS); 1 intermediate valve dredged at 91–95 m, 1 mile NE of Isla Manuelita (DRS).

Remarks: The specimens are in reddish brown tones, one maculated with cream on pleural areas. Their identification was confirmed by examination of the mounted girdle scales and radula.

*Lepidozona rothi* was previously recognized at Cocos Island, at Chatham Bay, 70–110 m, and off Nuez Id., at 55–90 m, (Ferreira 1983).

*Stenoplax* Dall, 1879

Type species: *Ischnochiton limaciformis* Sowerby, 1832, by original designation.

*Stenoplax boogii* (Haddon, 1886)

*Ischnochiton boogii* Haddon, 1886:15–16.

*Stenoplax boogii*: Ferreira, 1985:197–199, fig. 9.

Material examined: 5 specimens collected with SCUBA at 10–20 m, on Chatham Bay, largest 15.3 mm long (AJF 857; AJF 859); 3 specimens collected at 20–30 m, off Manuelita Id. (AJF 858; AJF 861); 2 specimens dredged at 46–53 m on Chatham Bay (DRS); 3 loose valves dredged at 18–61 m on Waifer Bay, Ulloa Id., and Roca Sucia (DRS).

Mopaliidae Dall, 1889

*Placiphorella* Dall, 1879

Type species: *Placiphorella velata* Dall, 1879, by original designation.

*Placiphorella blainvillii* (Broderip, 1832)

*Chiton blainvillii* Broderip in Broderip and Sowerby, 1832:27.

*Placiphorella blainvillii*: Dall, 1908:357; 1909:246—Hertlein, 1963:243—Smith and Ferreira, 1977:88–89, fig. 12.

*Placiphorella blainvillii* was reported by Dall (1908) dredged at 120 m "near Cocos Island." The single specimen (USNM 122968) was previously examined and illustrated (Smith and Ferreira 1977).

Family Chitonidae Rafinesque, 1815

*Chiton* Linnaeus, 1758

Type species: *Chiton tuberculatus* Linnaeus, 1758, by subsequent designation (Dall 1879).

*Chiton stokesii* Broderip, 1832

*Chiton stokesii* Broderip in Broderip and Sowerby, 1832:25–26—Thorpe in Keen, 1971:864, Polyplacophora, sp./fig. 5.

Material examined: 25 specimens, largest 73 mm long, collected at Chatham Bay, in the intertidal zone, exposed on large boulders (AJF 856).

Remarks: *Chiton stokesii* is very abundant at Cocos Island, on top of large boulders in the intertidal zone. The species has been reported at Cocos by several authors (Biolley 1907; Dall 1908; Tomlin 1927; Hertlein 1963; Emerson and Old 1964; Montoya 1983). Largest specimen reported at the island, 110 mm long (Biolley 1907).

*Chiton goodallii* Broderip, 1832

*Chiton goodallii* Broderip in Broderip and Sowerby, 1832:25—Thorpe in Keen, 1971:864, Polyplacophora, sp./fig. 4.

Reports of *Chiton goodallii* at Cocos (Martens 1902; Boone 1933) have not been corroborated; very likely, these reports represent misidentifications for *C. stokesii*. The species is only known at the Galápagos Islands (Smith and Ferreira 1977).

Suborder Acanthochitonina Bergenhayn, 1930

Family Acanthochitonidae Pilsbry, 1893

*Acanthochitona* Gray, 1821

Type species: *Chiton fascicularis* Linnaeus, 1767, by monotypy.

*Acanthochitona hirudiniformis* (Sowerby 1832)

*Chiton hirudiniformis* Sowerby in Broderip and Sowerby, 1832:59.

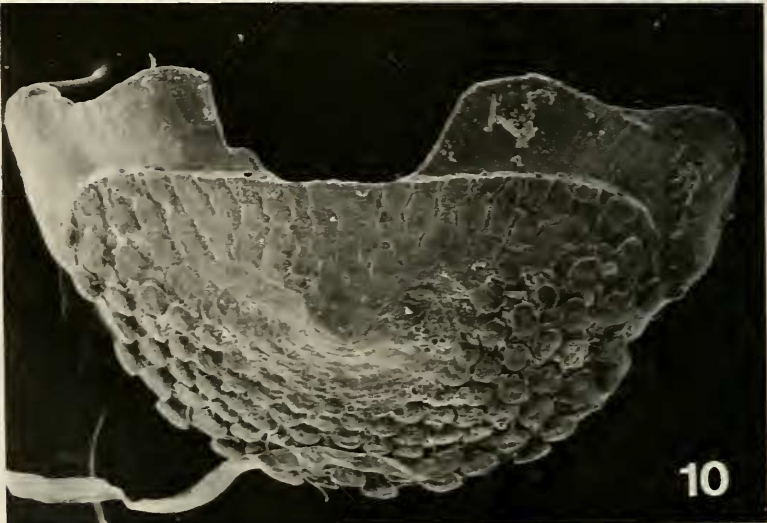
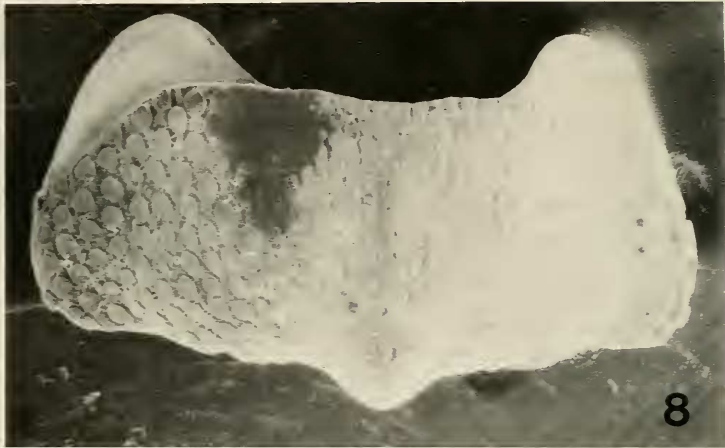
*Acanthochitona hirudiniformis*: Hertlein, 1963:242—Thorpe in Keen 1971:866–868, Polyplacophora, sp./fig. 13—Smith and Ferreira 1977:92–93, fig. 17—Montoya 1983:345.

The single report of *Acanthochitona hirudiniformis* at Cocos Island (Hertlein 1963) has not been corroborated; Hertlein's (op. cit.) material has not been found in the CAS chiton collection.

*Acanthochitona shaskyi* Ferreira, spec. nov.

Figs. 8–12

Diagnosis: Small (up to 6 mm long) *Acanthochitona*, valves all yellow, all white, or maculated cream with red; girdle banded cream and red. Jugal area much wider in front, with microgranules defining irregular longitudinal striae. Latero-pleural





areas with round, flat-topped pustules. Mucro central or slightly anterior, not prominent. Girdle covered with small, spiculoid elements; tufts with relatively short (up to 0.5 mm long), glassy, white spines. Conspicuous marginal fringe of white and reddish spicules. Radula with tricuspid major lateral teeth.

Type material and locality: Holotype (CAS 061094) and paratypes (CAS 061095; LACM 2125; SBMNH 34359; USNM 859008; D. R. Shasky Colln.; A. J. Ferreira Colln.); locality, Chatham Bay, Cocos Island, Costa Rica (5°33'N, 87°02'W) at 46–69 m.

Description: Holotype, intact, flat, preserved in alcohol, 48 mm long, 27 mm wide (including girdle but not the spicular fringe. Valves subcarinate, slightly beaked. Tegmentum cream colored maculated with reddish brown. Jugum much wider in front (Fig. 8); surface covered with minute granules, aligned longitudinally, defining about 10–12 fine striae. Pleurolateral areas covered with small, round, flat-topped pustules (Fig. 9); anterior valve and postmucro area of posterior valve similarly sculpture. Mucro anterior (Fig. 10); postmucro slightly concave. Girdle banded dark brown and cream, covered with very small, round elements; sutural tufts with relatively short, and sparse, transparent, sharp spines; marginal fringe of transparent, glassy spicules, about 300  $\mu\text{m}$  long.

Paratypes do not differ significantly from holotype in general characteristics. Largest specimen  $6.2 \times 3.2$  mm, smallest  $2.8 \times 1.7$  mm; "average" specimen in the lot about 4 mm long. In alcohol preserved specimens, width/length, 0.55 ( $n = 12$ ;  $SD = 0.027$ ). Among 91 specimens in type lot, 74 (81%) are cream colored variously maculated with reddish brown, 16 (18%) uniformly bright yellow, 1 (1%) yellowish white.

Girdle uniformly paved with round to ovoid elements, about 5  $\mu\text{m}$  in diameter, transparent or brown (Fig. 11A) as reflected in sharp white and brown banding seen in all specimens. Sutural tufts relatively inconspicuous; girdle pores 100–150  $\mu\text{m}$  diameter, 400  $\mu\text{m}$  apart, with straight, glassy spicules up to 500  $\mu\text{m}$  long, 15  $\mu\text{m}$  thick (Fig. 11B). Conspicuous marginal fringe of glassy, longitudinally striated spicules, up to 350  $\mu\text{m}$  long, 35  $\mu\text{m}$  thick (Fig. 11C), whitish or reddish corresponding to color of girdle. Girdle undersurface with transparent, lanceolate, somewhat imbricated scales,  $40 \times 10$   $\mu\text{m}$  (Fig. 10D).

Radula (of specimen 6 mm long) 1.8 mm long, 35 rows; median teeth 23  $\mu\text{m}$  wide at anterior blade; first lateral teeth about 45  $\mu\text{m}$  long (Fig. 12A); major lateral teeth with tricuspid head (cusps all about same size), 40  $\mu\text{m}$  wide (Fig. 12B); outer marginal teeth  $40 \times 20$   $\mu\text{m}$  (length/width ratio, 2.0).

Distribution: *Acanthochitona shaskyi* is known only from the type lot.

Remarks: Given the usual difficulties in the differential diagnosis of species of *Acanthochitona*, *A. shaskyi* must be carefully distinguished from congeners in

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Fig. 8. *Acanthochitona shaskyi* Ferreira, spec. nov. Paratype (CAS 061095): Intermediate valve, dorsal surface. SEM micrograph, courtesy of Terrence Gosliner.

Fig. 9. *Acanthochitona shaskyi* Ferreira, spec. nov. Paratype (CAS 061095): Same specimen as in Fig. 7. Close-up of latero-pleural areas ( $\times 170$ ). SEM micrograph, courtesy of Terrence Gosliner.

Fig. 10. *Acanthochitona shaskyi* Ferreira, spec. nov. Paratype (CAS 061095): Posterior valve, dorsal surface. SEM micrograph, courtesy of Terrence Gosliner.

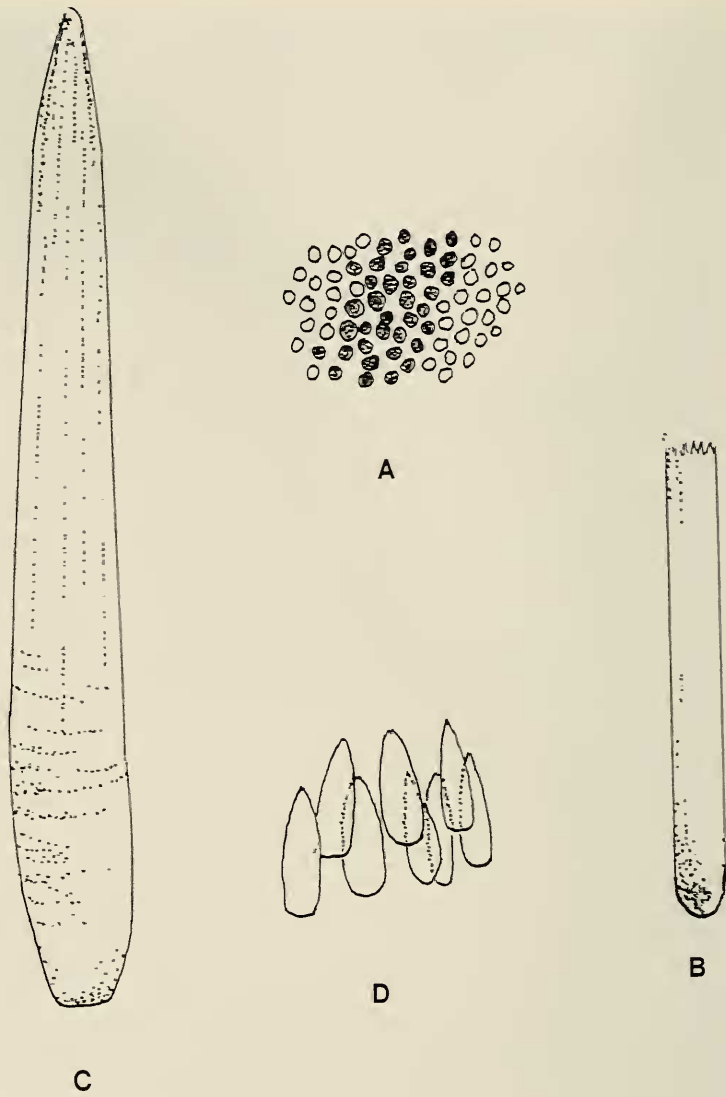


Fig. 11. *Acanthochitona shaskyi* Ferreira, spec. nov. Paratype (CAS 061095): Girdle elements: A—Scale-like elements of upper surface; B—Fragment of glassy spicule from sutural tuft; C—Spicule from marginal fringe; D—Scales of girdle undersurface. Camera lucida drawings. Bar = 100  $\mu$ m.

the area, *A. hirudiniformis* (Sowerby, 1832), *A. arragonites* (Carpenter, 1857), *A. avicula* (Carpenter, 1864), and *A. jacquelinae* Smith and Ferreira, 1977.

Although *A. hirudiniformis* has been reported at Cocos (Hertlein 1963) the two species are too different in size, shape, color and sculpture of tegmentum, and girdle elements, to cause confusions in identification.

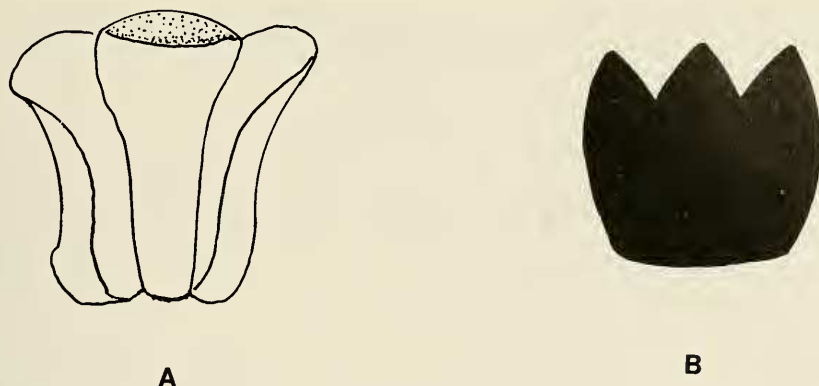


Fig. 12. *Acanthochitona shaskyi* Ferreira, spec. nov. Paratype (CAS 061095): Radula: A—Median and first lateral teeth; B—Head of major lateral tooth. Camera lucida drawings. Bar = 50  $\mu$ m.

Unlikely to be confused, also, is *A. avicula* on account of its different size, and color; in addition the two species differ in the shape of the lateropleural areas pustules (tear-drop in *A. avicula*; round to suboval in *A. shaskyi*), and the mucro (prominent, central in *A. avicula*; subdued, anterior in *A. shaskyi*).

*Acanthochitona arragonites*, also quite small in size, and often with color patterns similar to those of *A. shaskyi*, may pose some difficulties in differentiation;

Table 1. *Acanthochitona shaskyi* Ferreira, spec. nov. versus *A. jacquelineae* Smith and Ferreira, 1977: Comparison of characters based on same size (about 6 mm long) specimens.

	<i>A. jacquelineae</i> (n = 41)	<i>A. shaskyi</i> (n = 91)
Specimens' color (%)		
Mottled cream-red	54	81
All yellow	37	18
All white	10	1
Specimen length (mm), max.	10	6
Jugal area	striated	striated
Lateropleural pustules top	flat to concave	flat
Diameter ( $\mu$ m), max.	80	80
Mucro, central	prominent	subdued
Postmucro slope	sharp	gentle
Girdle,		
Banding	inconspicuous	conspicuous
Pores diameter ( $\mu$ m)	300	150
Apart ( $\mu$ m)	200	450
Spicules in tufts		
Length ( $\mu$ m), max.	1500	500
Width ( $\mu$ m), max.	30	20
Radula, major lateral teeth tricuspid head, width ( $\mu$ m)	50	35

however, it suffices to point out that specimens of *A. arragonites* are clearly parallel-sided (i.e., not oval), with a distinctly elongate body, and a smooth jugal area.

However, the differential diagnosis between *A. shaskyi* and *A. jacquelineae* (endemic to the Galápagos Islands) must be carefully spelled out. Specimens of two species are about the same size, and color; in fact, both species take the same 3 color forms, cream mottled with brownish red, all-yellow, and all-white, albeit in possibly different proportions (Table 1). In addition, they have identical radulae, and rather similar girdle elements. They do differ, however, in 1) the spines at the sutural tufts (quite long, up to 1500  $\mu\text{m}$ , in *A. jacquelineae*; short, up to 500  $\mu\text{m}$ , in *A. shaskyi*), 2) the girdle pores (wide, 300–350  $\mu\text{m}$  in diameter, 300–400  $\mu\text{m}$  apart, in *A. jacquelineae*; narrow, 100–150  $\mu\text{m}$  in diameter, 500–600  $\mu\text{m}$  apart, in *A. shaskyi*), 3) the mucro (prominent in *A. jacquelineae*; subdued in *A. shaskyi*), and 4) the postmucro slope (sharp, near 90° in *A. jacquelineae*; gentle, near 45° in *A. shaskyi*).

#### Acknowledgments

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